

We claim:

1. A removable imbibition composition comprising:
 - (a) a photochromic performance improving amount of kinetic enhancing additive(s) comprising polyols or a mixture of polyols and epoxy-containing compounds; and
 - (b) photochromic compound(s),

wherein upon the application of the composition to the surface of an organic polymeric article, the kinetic enhancing additive(s) and photochromic compound(s) are transferred into the polymeric article and the residual imbibition coating(s) formed from the composition(s) is removed from the polymeric article.

2. The composition of claim 1 further comprising at least one of ultraviolet light absorber(s), antioxidant(s), rheology control agent(s), or leveling agent(s).

3. The composition of claim 1 further comprising a carrier of solvent(s), polymeric resin(s), or a mixture thereof, provided said polymeric resin is different from the kinetic enhancing additive.

4. The composition of claim 1 wherein the kinetic enhancing additive is present in an amount of from 0.1 to 99.9 weight percent, based on the total weight of the composition.

5. The composition of claim 1 wherein the amount of kinetic enhancing additive added is an amount that results in at least a 10 percent improvement in the Photochromic Performance Test when compared to a similar composition for the imbibition process without said kinetic enhancing additive.

6. The composition of claim 1 wherein the polyol(s) is polyester polyols, polyether polyols, amide-containing polyols, polyhydric polyvinyl alcohols or a mixture thereof.

5 7. The composition of claim 6 wherein the kinetic enhancing additive is polycaprolactone diol, poly(ethylene glycol), hexane diol, polytetrahydrofuran diol, or a mixture thereof.

8. The composition of claim 6 wherein the polyester polyol is
10 represented by the following formula:

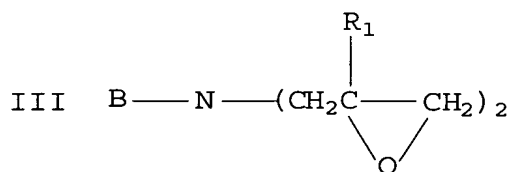
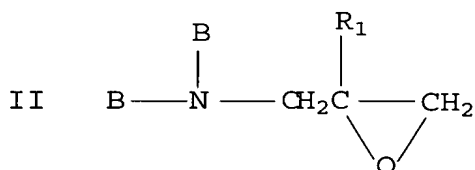
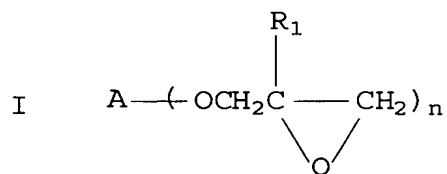


wherein:

15 X is -O- or -NR₁₀-; R₁₀ is hydrogen or C₁-C₁₂ alkyl; R₆ is an organic radical derived from an initiator; R₇, R₈ and R₉ are each selected independently from hydrogen, C₁-C₁₂ alkyl, C₅-C₆ cycloalkyl, C₁-C₆ alkoxy, benzyl or phenyl, provided that at least h+2 of the total number of R₇, R₈ and R₉ are hydrogen; h is an integer from 1 to 6; t is an integer from 1 to 100; and y is an integer equal to from 2 to 6.

20

9. The composition of claim 1 wherein the epoxy-containing compound(s) is represented by graphic formulae I, II, III or a mixture thereof:

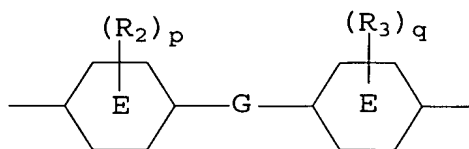


wherein

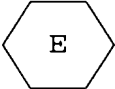
(i) R_1 is hydrogen or C_1 - C_3 alkyl;

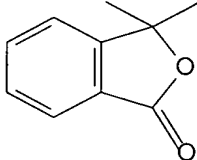
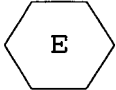
(ii) n is the integer one, two, three or four; when n is one, A is C_2 - C_{20} alkyl, substituted C_2 - C_{20} alkyl, C_3 - C_{20} cycloalkyl, substituted C_3 - C_{20} cycloalkyl; the unsubstituted or substituted aryl groups, phenyl and naphthyl; aryl(C_1 - C_3)alkyl, substituted aryl(C_1 - C_3)alkyl, acryloxy, methacryloxy; the group $-\text{C}(\text{O})\text{Y}$, wherein Y is C_2 - C_{20} alkyl, C_1 - C_6 alkoxy or aryl; or the group $-\text{R}(\text{OR})_m\text{-OH}$ or $-(\text{OR})_m\text{-OH}$, wherein R is C_2 - C_4 alkylene and m is an integer from 1 to 20; said alkyl and cycloalkyl substituents being carboxy, hydroxy or C_1 - C_3 alkoxy, said aryl and aryl(C_1 - C_3)alkyl substituents being carboxy, hydroxy, C_1 - C_3 alkoxy or C_1 - C_3 alkyl; or when n is from two to four, A is C_2 - C_{20} alkylene, substituted C_2 - C_{20} alkylene, C_3 - C_{20} cycloalkylene, substituted C_3 - C_{20} cycloalkylene; the unsubstituted or substituted arylene groups, phenylene and naphthylene; aryl(C_1 - C_3)alkylene, substituted aryl(C_1 - C_3)alkylene; the group $-\text{C}(\text{O})\text{Z}(\text{O})\text{C}-$ wherein Z is C_2 - C_{20} alkylene or arylene; the group $-\text{R}(\text{OR})_m-$ or $-(\text{OR})_m-$, wherein R and m are the same as defined hereinbefore; phthaloyl, isophthathoyl, terephthaloyl; hydroxyl-substituted

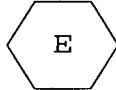
phthaloyl, hydroxy-substituted isophthaloyl, hydroxy-substituted terephthaloyl; or a group represented by the following graphic formula:



wherein R_2 and R_3 are each C_1 - C_4 alkyl, chlorine or bromine; p and q are each an

5 integer from 0 to 4;  represents a divalent benzene group or a divalent cyclohexane group; G is $-O-$, $-S-$, $-S(O_2)-$, $-C(O)-$, $-CH_2-$, $-CH=CH-$, $-C(CH_3)_2-$,

$-C(CH_3)(C_6H_5)-$, $-(C_6H_4)-$ or  when  is the divalent

benzene group; or G is $-O-$, $-S-$, $-CH_2-$, or $-C(CH_3)_2-$, when  is the divalent

cyclohexane group; said alkylene and cycloalkylene substituents being carboxy, hydroxy or C_1 - C_3 alkoxy; said arylene and aryl(C_1 - C_3)alkylene substituents being carboxy, hydroxy, C_1 - C_3 alkoxy or C_1 - C_3 alkyl; and

(iii) B is C_2 - C_{20} alkyl, substituted C_2 - C_{20} alkyl, C_3 - C_{20} cycloalkyl, substituted C_3 - C_{20} cycloalkyl; the unsubstituted or substituted aryl groups, phenyl and naphthyl; aryl(C_1 - C_3)alkyl or substituted aryl(C_1 - C_3)alkyl; said alkyl and cycloalkyl substituents being carboxy, hydroxy or C_1 - C_3 alkoxy, said aryl and aryl(C_1 - C_3)alkyl substituents being carboxy, hydroxy, C_1 - C_3 alkoxy or C_1 - C_3 alkyl.

10. The composition of claim 9 wherein R_1 is hydrogen; A is C_2 - C_{10} alkyl, phenyl, $-R-(OR)_m-OH$ or $-(OR)_m-OH$, wherein R is C_2 - C_4 alkylene and m is an integer from 1 to 20, when n is one; or when n is from two to four, A is

selected from C₂-C₁₀ alkylene, phenylene, -R-(OR)_m- or -(OR)_m-, wherein R and m are the same as defined hereinbefore; or phthaloyl; B is selected from C₂-C₁₀ alkyl, phenyl or phenyl(C₁-C₃)alkyl.

5 11. The composition of claim 1 wherein the epoxy-containing compound is ethylene glycol glycidyl ether, propylene glycol glycidyl ether, glycerol polyglycidyl ether, diglycerol polyglycidyl ether, glycerol propoxylate triglycidyl ether, trimethylolpropane triglycidyl ether, sorbitol polyglycidyl ether, butyl glycidyl ether, phenyl glycidyl ether, poly(ethylene glycol)diglycidyl ether, poly(propylene glycol)diglycidyl ether, neopentyl glycol diglycidyl ether, N,N-diglycidyl-4-
10 glycidyloxyaniline, glycidyl phthalimide, N,N'-diglycidyltoluidine, 1,6-hexane diol diglycidyl ether, diglycidyl 1,2-cyclohexanedicarboxylate, bisphenol A or hydrogenated bisphenol A propylene oxide adduct, diglycidyl ester of terephthalic acid, diglycidyl 1,2,3,6-tetrahydrophthalate, spiroglycoldiglycidyl ether,
15 hydroquinone diglycidyl ether or a mixture thereof.

 12. The composition of claim 11 wherein the epoxy-containing compound is polyethylene glycol diglycidyl ether, trimethylol propane triglycidyl ether, N,N-diglycidyl-4-glycidyloxyaniline, diglycidyl-1,2,3,6-tetrahydrophthalate,
20 glycerol propoxylate triglycidyl ether, diglycidyl-1,2-cyclohexane dicarboxylate or a mixture thereof.

 13. The composition of claim 1 wherein the kinetic enhancing additive is a mixture of trimethylolpropane triglycidylether and polycaprolactone diol.
25

 14. The composition of claim 1 wherein the photochromic compound(s) have at least one activated absorption maxima within the range of 400 and 700 nanometers.

30 15. The composition of claim 14 wherein the photochromic compound(s) are selected from naphthopyrans, benzopyrans, indenonaphthopyrans,

quinopyrans, phenanthropyrans, oxazines, metal dithizonates, fulgides, fulgimides or mixtures thereof.

16. The composition of claim 3 wherein the carrier is water,
5 benzene, toluene, methyl ethyl ketone, acetone, ethanol, tetrahydrofurfuryl alcohol, n-methyl pyrrolidone, 2-ethoxyethyl ether, 2-methoxyethyl ether, xylene, cyclohexane, 3-methyl cyclohexanone, ethyl acetate, tetrahydrofuran, methanol, methyl propionate, ethylene glycol, hydroxy(C₁-C₃)alkyl cellulose, poly(vinyl pyrrolidone), polyvinyl chloride, polyvinyl acetate, polyvinyl butyral, polyvinyl propionate, cellulose acetate
10 butyrate or a mixture thereof.

17. A process for imparting photochromism to an organic
polymeric host material comprising transferring a photochromic amount of
photochromic compound(s) and a photochromic performance improving amount of
15 kinetic enhancing additive(s) comprising polyol(s), epoxy-containing compounds or a mixture of polyols and epoxy-containing compounds into said organic polymeric host material.

18. The process of claim 17 wherein the transferring of
20 photochromic compounds and kinetic enhancing additives is done from a carrier of solvent, polymeric resin or a mixture thereof, provided said polymeric resin is different from the kinetic enhancing additive.

19. The process of claim 18 further comprising removing carrier
25 residual from the surface of the organic polymeric host.

20. The process of claim 17 wherein the transferring of a
photochromic amount of photochromic compound(s) and a photochromic
performance improving amount of kinetic enhancing additive(s) is accomplished by a
30 transferring order step selected from the group consisting of:

- (a) transferring kinetic enhancing additive(s) prior to transferring photochromic compound(s);
- (b) transferring photochromic compound(s) prior to transferring kinetic-enhancing additive(s); and
- 5 (c) transferring kinetic enhancing additive(s) and photochromic compound(s) together.

21. The process of claim 17 wherein the transferring of a photochromic amount of photochromic compound(s) and a photochromic
10 performance improving amount of kinetic enhancing additive(s) is accomplished by a transferring order step selected from the group consisting of:

- (a) transferring a portion of the photochromic performance improving amount of kinetic enhancing additive prior to transferring the photochromic compound and the remainder of
15 the photochromic performance improving amount of kinetic enhancing additive;
- (b) transferring a portion of the photochromic amount of photochromic compound prior to transferring the kinetic enhancing additive and the remainder of the photochromic
20 amount of photochromic compound; and
- (c) transferring a portion of the photochromic performance improving amount of kinetic enhancing additive and a portion of the photochromic amount of photochromic compound prior to transferring the remainder of each.

25

22. The process of claim 17 wherein the transferring of photochromic compounds and kinetic enhancing additives is done with at least one of ultraviolet light absorber(s), ultraviolet light stabilizer(s), antioxidant(s), rheology control agent(s), or leveling agent(s).

30

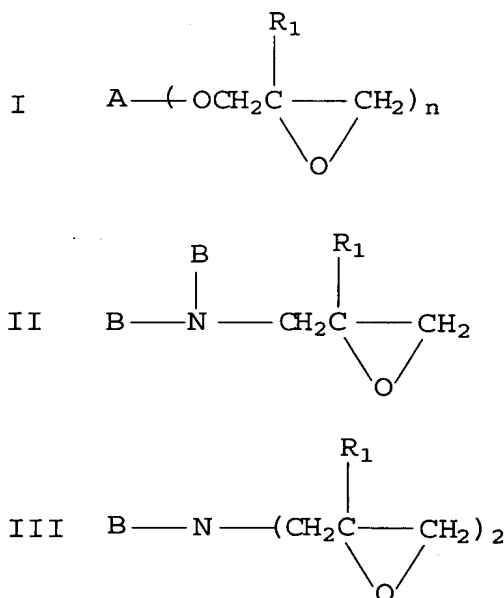
23. The process of claim 17 wherein the polyol(s) is selected from polyester polyols, polyether polyols, amide-containing polyols, polyhydric polyvinyl alcohols or a mixture thereof.

5 24. The process of claim 23 wherein the kinetic enhancing additive is selected from polycaprolactone diol, poly(ethylene glycol), hexane diol, polytetrahydrofuran diol, or a mixture thereof.

10 25. The process of claim 17 wherein the mixture of polyols and epoxy-containing compounds is in a weight proportion of from 1:99 to 99:1.

26. The process of claim 25 wherein the polyol is polycaprolactone diol and the epoxy-containing compound is trimethylolpropane triglycidyl ether.

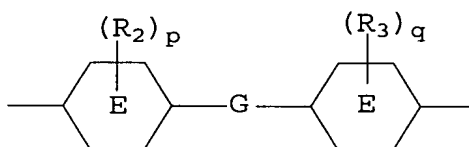
15 27. The process of claim 17 wherein the epoxy-containing compound(s) is represented by graphic formulae I, II, III or a mixture thereof:



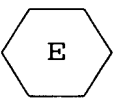
wherein

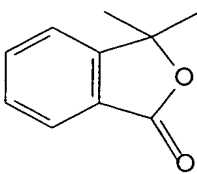

(i) R_1 is hydrogen or C_1 - C_3 alkyl;

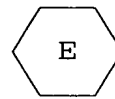
(ii) n is the integer one, two, three or four; when n is one, A is C₂-C₂₀ alkyl, substituted C₂-C₂₀ alkyl, C₃-C₂₀ cycloalkyl, substituted C₃-C₂₀ cycloalkyl; the unsubstituted or substituted aryl groups, phenyl and naphthyl; aryl(C₁-C₃)alkyl, substituted aryl(C₁-C₃)alkyl, acryloxy, methacryloxy; the group -C(O)Y, wherein Y is C₂-C₂₀ alkyl, C₁-C₆ alkoxy or aryl; or the group -R-(OR)_m-OH or -R-(OR)_m-OH, wherein R is C₂-C₄ alkylene and m is an integer from 1 to 20; said alkyl and cycloalkyl substituents being carboxy, hydroxy or C₁-C₃ alkoxy, said aryl and aryl(C₁-C₃)alkyl substituents being carboxy, hydroxy, C₁-C₃ alkoxy or C₁-C₃ alkyl; or when n is from two to four, A is C₂-C₂₀ alkylene, substituted C₂-C₂₀ alkylene, C₃-C₂₀ cycloalkylene, substituted C₃-C₂₀ cycloalkylene; the unsubstituted or substituted arylene groups, phenylene and naphthylene; aryl(C₁-C₃)alkylene, substituted aryl(C₁-C₃)alkylene; the group -C(O)Z(O)C- wherein Z is C₂-C₂₀ alkylene or arylene; the group -R-(OR)_m- or -R-(OR)_m-, wherein R and m are the same as defined hereinbefore; phthaloyl, isophthathoyl, terephthaloyl; hydroxyl-substituted phthaloyl, hydroxy-substituted isophthaloyl, hydroxy-substituted terephthaloyl; or a group represented by the following graphic formula:




wherein R₂ and R₃ are each C₁-C₄ alkyl, chlorine or bromine; p and q are each an

integer from 0 to 4;  represents a divalent benzene group or a divalent cyclohexane group; G is -O-, -S-, -S(O₂)-, -C(O)-, -CH₂-, -CH=CH-, -C(CH₃)₂-,

-C(CH₃)(C₆H₅)-, -(C₆H₄)- or  when  is the divalent



benzene group; or G is -O-, -S-, -CH₂-, or -C(CH₃)₂-, when  is the divalent cyclohexane group; said alkylene and cycloalkylene substituents being carboxy, hydroxy or C₁-C₃ alkoxy; said arylene and aryl(C₁-C₃)alkylene substituents being carboxy, hydroxy, C₁-C₃ alkoxy or C₁-C₃ alkyl; and

- 5 (iii) B is C₂-C₂₀ alkyl, substituted C₂-C₂₀ alkyl, C₃-C₂₀ cycloalkyl, substituted C₃-C₂₀ cycloalkyl; the unsubstituted or substituted aryl groups, phenyl and naphthyl; aryl(C₁-C₃)alkyl or substituted aryl(C₁-C₃)alkyl; said alkyl and cycloalkyl substituents being carboxy, hydroxy or C₁-C₃ alkoxy, said aryl and aryl(C₁-C₃)alkyl substituents being carboxy, hydroxy, C₁-C₃ alkoxy or C₁-C₃ alkyl.
- 10

28. The process of claim 27 wherein the epoxy-containing compound is polyethylene glycol diglycidyl ether, trimethylol propane triglycidyl ether, N,N-diglycidyl-4-glycidyloxyaniline, diglycidyl-1,2,3,6-tetrahydrophthalate, glycerol propoxylate triglycidyl ether, diglycidyl-1,2-cyclohexane dicarboxylate or a mixture thereof.

15

29. The process of claim 17 wherein the photochromic compound(s) have at least one activated absorption maxima within the range of 400 and 700 nanometers.

20

30. The process of claim 18 wherein the carrier is water, benzene, toluene, methyl ethyl ketone, acetone, ethanol, tetrahydrofurfuryl alcohol, n-methyl pyrrolidone, 2-ethoxyethyl ether, 2-methoxyethyl ether, xylene, cyclohexane, 3-methyl cyclohexanone, ethyl acetate, tetrahydrofuran, methanol, methyl propionate, ethylene glycol, hydroxy(C₁-C₃)alkyl cellulose, poly(vinyl pyrrolidone), polyvinyl chloride, polyvinyl acetate, polyvinyl butyral, polyvinyl propionate, cellulose acetate butyrate or a mixture thereof.

25

31. The process of claim 17 wherein the organic polymeric host material is selected from poly(urea-urethane), poly(C₁-C₁₂ alkyl methacrylates), poly(oxyalkylene) dimethacrylates, poly(alkoxylated phenol methacrylates), cellulose acetate, cellulose triacetate, cellulose acetate propionate, cellulose acetate butyrate, poly(vinyl acetate), poly(vinyl alcohol), poly(vinyl chloride), poly(vinylidene chloride), thermoplastic polycarbonates, polyesters, polyurethanes, polythiourethanes, poly(ethylene terephthalate), polystyrene, poly(alpha methylstyrene), copoly(styrene-methylmethacrylate), copoly(styrene-acrylonitrile), polyvinylbutyral and polymers of polyol(allyl carbonate) monomers, polyfunctional acrylate monomers, polyfunctional methacrylate monomers, diethylene glycol dimethacrylate monomers, diisopropenyl benzene monomers, ethoxylated bisphenol A dimethacrylate monomers, ethylene glycol bismethacrylate monomers, poly(ethylene glycol) bismethacrylate monomers, ethoxylated phenol methacrylate monomers, alkoxylated polyhydric alcohol acrylate monomers, diallylidene pentaerythritol monomers, urethane acrylate monomers, vinylbenzene monomers, styrene monomers and mixtures of such monomers.

32. A product of the process of claim 17.

33. A product of the process of claim 18.

34. A product of the process of claim 19.

35. A product of the process of claim 20.

36. A product of the process of claim 21.

37. A product of the process of claim 22.